CLAIMS

1. A method for producing a supercritical water (SCW)-treated product, the method comprising the steps of:

introducing a mixed stream comprising hot oil and supercritical water to a convection section of a furnace, where conversion reactions occur in the convection section, wherein the furnace comprises a convection section and a radiation section;

upgrading the mixed stream in the convection section of the furnace to produce a convection upgraded stream at a temperature of between the critical temperature of water and 500 deg C;

introducing the convection upgraded stream to a supercritical reactor, where the supercritical reactor is maintained at a temperature between 380 deg C and 450 deg C and a pressure between 23 MPa and 35 MPa, wherein one or more conversion reactions occur in the supercritical reactor;

upgrading the convection upgraded stream in the supercritical reactor to produce a reactor effluent;

introducing the reactor effluent to a post-reaction stage to produce the SCW-treated product, wherein the SCW-treated product comprises an increased paraffin concentration as compared to the crude oil stream, wherein the SCW-treated product comprises an amount of water;

introducing the SCW-treated product to the convection section of the furnace;

mixing a first fraction of components of the SCW-treated product with the mixed stream such that some components of the SCW-treated product are in the convection upgraded stream;

flowing a second fraction of components of the SCW-treated product to the radiation section of the furnace;

mixing the second fraction of components of the SCW-treated product that flow to the radiation section of the furnace with diluents in the radiation section of the furnace;

upgrading the second fraction of components of the SCW-treated product in the radiation section of the furnace to produce a furnace effluent, where the second fraction of components of the SCW-treated product are subjected to radical-mediated reactions; and

withdrawing the furnace effluent from the radiation section of the furnace.

2. The method of claim 1, wherein the post-reaction stage is configured to adjust the amount of water in the SCW-treated product.

3. The method of claim 1, further comprising the steps of:

introducing the SCW-treated product to an intermediate unit to produce a product stream; and

introducing the product stream to the convection section of the furnace, where the product stream is subjected to one or more conversion reactions, where components of the product stream flow to the radiation section of the furnace and mix with the diluents in the radiation section of the furnace to produce the furnace effluent, where the furnace effluent is withdrawn from a radiation section of the furnace.

4. The method of claim 3, wherein the intermediate unit is selected from the group consisting of a hydrotreating process, a distillation process, and a thermal conversion process.

5. The method of claim 3, wherein the intermediate unit is a hydrotreating process, and wherein the product stream is a hydrotreating process product.

6. The method of claim 5, wherein the crude oil stream comprises a concentration of a vacuum residue fraction that is greater than 20 wt %, wherein the crude oil stream comprises a total sulfur content that is greater than 1.5 wt % sulfur.

7. The method of claim 5, wherein the amount of water in the SCW-treated product is less than 1,000 wt ppm.

8. The method of claim 5, further comprising a step of introducing hydrogen gas to the hydrotreating process.

9. The method of claim 3, wherein the intermediate unit is a distillation process, further wherein the product stream is a distilled product.

10. The method of claim 9, wherein the distillation process is selected from the group consisting of an atmospheric distillation unit, a vacuum distillation unit, and a combination thereof.

11. The method of claim 9, wherein the crude oil stream comprises a vacuum residue fraction that is greater than 20 wt %.

12. The method of claim 9, wherein the SCW-treated product comprises a concentration of a vacuum residue fraction that is greater than 20 wt %.

13. The method of claim 9, wherein a cut point of distillation of the distillation process is between 650 deg F and 1050 deg F.

14. The method of claim 3, wherein the intermediate unit is a thermal conversion process, further wherein the product stream is a thermal liquid product.

15. The method of claim 14, wherein the thermal conversion process is selected from the group consisting of a coking process and a visbreaking process.

16. The method of claim 14, wherein the crude oil stream comprises a concentration of a vacuum residue fraction that is greater than 20 wt %.

17. The method of claim 14, wherein the thermal liquid product comprises a concentration of a vacuum residue fraction that is less than 5 wt %.

18. The method of claim 1, further comprising the steps of:

pressurizing a crude oil stream in a feed pump to a pressure at or greater than the critical pressure of water to produce a pressurized oil;

heating the pressurized oil in a feed heater to a temperature at or less than 150 deg C to produce a hot oil stream;

pressurizing a water stream in a water pump to a pressure at or greater than the critical pressure of water to produce a pressurized water;

heating the pressurized water in a water heater to a temperature at or greater than the critical temperature of water to produce a supercritical water stream; and

mixing the hot oil stream and the supercritical water stream to produce the mixed stream.

19. The method of claim 1, further comprising the steps of:

pressurizing a crude oil stream in a feed pump to a pressure at or greater than the critical pressure of water to produce a pressurized oil;

pressurizing a water stream in a water pump to a pressure at or greater than the critical pressure of water to produce a pressurized water; and

mixing the pressurized oil and the pressurized water to produce the mixed stream.